

Sarin's compilation

Pamphlet Physics

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Volumes/Mass/Weight/Density

Density

Density is compactness. The mass or quantity of matter of a substance per unit of its volume, proportional to its specific gravity since mass is proportional to weight.

DENSITY is the weight per unit volume of a substance, at a certain temperature (only stated for solids and liquids when great accuracy is required).

As stated above density of a substance is defined as its mass per unit volume i.e.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

(The density of pure water is about 1 gram per cubic centimetre when its temperature is 4 degree Celsius. if we compare the density of the liquid or solid with that of the same volume of water, we shall know its specific gravity)

The term density is also applied to such quantities as:

the ratio of the number of particles in a given volume, or the total amount of a quantity such as energy or momentum carried by a volume, to that volume, as in charge density, electron density, and energy density;

The luminous energy found in a unit volume of space—luminous density; and

The blackness of the image on film or on a photographic plate—photographic density

Relative Density

The ratio of the density of something to the density of a standard

Relative density is calculated by the following formula: -

$$\text{Relative density} = \frac{\text{Density of a substance}}{\text{Density of water}}$$

It has no unit.

Specific Gravity

The density of a substance relative to the density of water

The weight per unit volume of a substance compared with the weight of the same volume of water at a given temperature. It is therefore a simple number of ratios, and to determine the weight per cubic feet (or per cubic metre) of a substance, the specific gravity must be multiplied by 62.4 pounds per cubic feet (or 1000 kilograms per cubic metre), the density of water. In the metric system, 1 cubic centimetre of water at 4° C weighs 1 gram.

$$\text{Specific gravity} = \frac{\text{Weight of any volume of material}}{\text{Weight of equal volume of water}}$$

Specific gravity can be determined in a number of ways. Solid bodies, that have a higher specific gravity than water can be weighed separately in air and then in water. Specific gravity is obtained by dividing the weight in air by the loss of weight when the bodies are immersed in water. For measuring the specific gravity of liquids, a hydrometer is commonly used. For more measurements that are accurate, the weight of a known volume of liquid is

determined under controlled temperature conditions. The usual method of obtaining the specific gravity of gases is similar.

Gravimeter

Gravimeter is an instrument for measuring the specific gravity of a solid or liquid. And or is an instrument for measuring variations in the gravitational field of the earth.

Gravity meter

A measuring instrument for measuring variations in the gravitational field of the earth

Hydrometer

Hydrometer, in chemistry, graduated glass or metal instrument used to measure either the specific gravity or density of a liquid. It is based on the hydrostatic principle of the Greek mathematician and inventor Archimedes, which states that the weight loss of a body in a liquid equals the weight of the liquid displaced. Most hydrometers are enclosed in glass tubes fitted with rubber bulbs for drawing up the solution to be measured. The sealed instrument itself floats and has a bulblike bottom weighted with lead or mercury. When immersed, the graduated stem rises vertically to give a scale reading. Hydrometers must be calibrated according to the type of liquid to be tested and at a standard temperature, usually 4° C (39.2° F), or 20° C (68° F). Various types of hydrometers measure density or purity in storage batteries, ship boilers, soil, and milk.

Mass

The property of a body that causes it to have weight in a gravitational field

The amount of matter in a body – always the same for a same body and is referred to as its mass.

Mass is the amount of matter that a body contains and a measure of the inertial property of that body.

Mass is different from weight, which is a measure of the attraction of the earth for a given mass. Inertial mass and gravitational mass are identical. Weight, although proportional to mass, varies with the position of a given mass relative to the earth; thus, equal masses at the same location in a gravitational field will have equal weights.

A fundamental principle of classical physics is the law of conservation of mass, which states that matter cannot be created or destroyed. This law holds true in chemical reactions but is modified in cases where atoms disintegrate and matter is converted to energy or energy is converted to matter

Matter

Anything that has weight and occupies space is called Matter.

Volume

The amount of space a body occupies is called its Volume.

Weight

Dependent upon mass is the Weight of a body.

Weight is measure of the gravitational force exerted on an object Dependent upon mass is the Weight of a body.

Every material body near the earth's surface has weight, which is a measure of the earth's gravitational attraction for the body.

Unit Weight

The weight of unit volume of material or its density is called unit weight

Measurement of weight

The weight of an object may be determined by using a comparative method, either as with a chemical-laboratory balance, or by measuring the gravitational force directly by means of a spring scale, such as the familiar bathroom scale. The deflection of a spring scale depends on the local gravitational attraction; therefore, a spring scale would record different weights for the same mass (amount of matter) at locations with a different gravitational attraction. One kilogram of mass, for example, might weigh 2.2 pound at sea level at lat 45° N, but slightly less on the top of a high mountain or at the equator, although the mass remains unchanged. More dramatically, an object with 1 kilogram of mass might weigh 2.2 pound on earth but only 0.35 pound on the moon. This problem is avoided by using the so-called beam scale such as that employed in the chemical-laboratory balance. In this, two pans are suspended from a cross beam that rests on a fulcrum, and a pointer is used to indicate balance when equal masses are in both pans. Because both masses are subject to the same gravitational attraction, weighing is performed by comparison and is independent of the specific magnitude of the local gravitational attraction.

Gravity

Gravity is the force that attracts matter towards the centre of the earth and gives it its weight. The acceleration due to gravity is 32.2 feet per second (9.81456 metres per second) at sea level, but decreases slightly as the distance from the centre of the earth increases

Values of 'g'

At sea level and given latitudes

System	L = 0°	L = 10°	L = 20°	L = 30°	L = 40°	L = 50°	L = 60°
British	32.088	32.095	32.108	32.180	32.159	32.187	32.215
Metric	978.03	978.24	978.63	979.32	980.18	981.06	981.91

The above values of 'g' are calculated from Helmert's formula for results at sea level. (L = Latitude)

$$g = 980.617(1 - 0.002644 \cos 2L + 0.000007 \times \cos^2 2L)$$

Approximate Rule – Subtract 0.01 from 'g' for every 33 metres of height above sea level, but add it if below sea level

One pound = 'g' × poundal

g = Acceleration of gravity (32.2 feet or 9.82 Metres per second approximately)

Force, Acceleration & mass

In the fundamental formulae connecting force, mass, acceleration and energy the unit of force × 'g' is equal to the unit of mass; thus 'g' dynes equals one gramme and 'g' poundal equal one pound in the CGS system and the FPS system respectively.

However, engineers usually prefer to express both force and mass in poundal units, which involves including the value of "g" in the formulae.

By the second law of motion

$$\text{Force} = \frac{\text{Mass} \times \text{Acceleration}}{g}$$

$$\text{and Acceleration} = \frac{\text{Force} \times g}{\text{Mass}}$$

The above formulae express that the acceleration produced is proportional to the applied force and inversely proportional to the Mass accelerated.

Dyne

The Dyne is the force, which acting upon a gramme for 1 second gives it a velocity of 1 centimetre per second.

Erg

The Erg is the work done by a Dyne working through a distance of 1 centimetre.

Work

Work done is defined as the product of the component of the force along the displacement and the magnitude of the displacement.

$W = \text{force} \times \text{displacement}$

The SI unit of work done is Joule (J), is also Nm

Motion

Newton's Law of motion

First Law –The state of rest or of uniform, straight-line motion in bodies remains unchanged unless impressed by force.

Second law –Change of motion is proportional to, and in the direction of, the impressed force.

Third law –To every action, there is an equal reaction, e.g. a moving body resists the impressed force causing its motion.

If —

t = units of time (seconds);

u = initial velocity;

v = final velocity;

s = space traversed;

f = rate of acceleration or retardation

Then

Uniform motion	Accelerated motion	Retarded motion	Falling bodies
t	$\frac{s}{u}$	$\frac{v-u}{f} = \frac{2s}{u+v}$	$\frac{v}{g} = \frac{2s}{v} = \sqrt{\frac{2s}{g}}$
u	$\frac{s}{t}$	$v - ft = \frac{2s}{t} - v$	0
v	u	$u + ft = \frac{2s}{t} - u$	$gt = \frac{2s}{t} = \sqrt{2gs}$
st	ut	$ut + \frac{1}{2}ft^2 = \frac{1}{2}t(u+v)$	$\frac{1}{2}gt^2 = \frac{1}{2}tv = \frac{v^2}{2g}$
f	0	$\frac{v-u}{t}$	$\frac{v}{t} = g$
Average velocity = $\frac{1}{2}(u+v)$			
Space traversed during the n^{th} second = $u + f\left(n - \frac{1}{2}\right)$			

g = acceleration of gravity = approximately 32.2 feet or 981 centimetres or 9.81 metres per second.

Acceleration & speed

Acceleration is the time rate of increased velocity. Unit of acceleration is the acceleration of a body whose velocity or speed increases in each second by 1 centimetre per second.

$$\text{Uniform acceleration} = \frac{v-u}{t}$$

Final velocity = v ; Initial velocity = u ; A = acceleration

$u = 0$ when a car or train starts from the rest and $A = \frac{v}{t}$

t = time (elapsing between v and u) = $\frac{v-u}{A}$

Acceleration is usually expressed in feet per second per second, and then ' v ' and ' u ' are in feet per second, and ' t ' in seconds.

(Acceleration is the time rate of increased velocity. Unit of acceleration is the acceleration of a body whose velocity or speed increases in each second by 1 centimetre per second.)

Distance covered during uniform acceleration = $d = \frac{1}{2} \times t \times (u+v)$; $d = \frac{1}{2} \times v \times t$

If the vehicle starts from rest then

Average speed or velocity $= \frac{v+u}{2}$ ('A' being uniform)

Escape velocity

To escape from the earth completely, an object near its surface needs a speed of at least 11000 metres per second.

Mach

Mach (followed by a number) is a measurement of speed, especially that of an aircraft, etc. Mach-one is speed of sound. Mach-two is twice the speed of sound.

Calorie

Calorie is metric unit of heat measurement. The small, or gram, calorie (cal) is usually specified in science and engineering as the amount of heat required to raise the temperature of 1 gram of water from 14.5° to 15.5° C. The temperature interval is sometimes specified in other ways. The definition that is now generally accepted is standard in thermo chemistry, is that 1 calorie is equal to 4.1840 joules (J).

A slightly different calorie is used in engineering, the international calorie, which equals 1/860 international watt-hour (Wh).

A large calorie, or kilocalorie (Cal), usually referred to as a calorie and sometimes as a kilogram calorie, equals 1000 cal. calorie is the unit used to express the amount of energy that a food provides when consumed. Calories supply the energy necessary for the body to function, but when intake exceeds the amount burned, the extra calories are stored as fat cells; if fewer calories are consumed than are needed, and energy is obtained from the fat cells.

Specific Heat

The relative amount of heat required to raise the temperature of a unit mass of different substance one degree compared with the amount of heat required to raise the temperature of same weight of water one degree.

Latent Heat

Latent heat is the heat absorbed by a substance, without altering its temperature, in changing from the solid to the liquid state, or from the liquid to the gaseous state, i.e., heat required to melt ice at 32° F to water at 32° F, or heat required to change water at 212° F to steam at 212° F.

British thermal unit

British thermal unit, in science and engineering, a unit measurement of heat or energy, usually abbreviated as Btu or BTU. One Btu was originally defined as the quantity of heat required to raise the temperature of 1 pound (0.45 kilogram) of water from 59.5° F (15.3° C) to 60.5° F (15.8° C) at constant pressure of 1 atmosphere; for very accurate scientific or engineering measurements, however, this value was not precise enough. The Btu has now been

redefined in terms of the joule as equal to 1055 joules; in engineering, a Btu is equivalent to 0.293 watt-hours approximately.

Temperature

Temperature is the Degree of heat possessed by a body.

The temperature scale adopted by the 1960 conference was based on a fixed temperature point, the triple point of water, at which the solid, liquid, and gas are in equilibrium. The temperature of 273.16 Kelvin (K) was assigned to this point. The freezing point of water was designated as 273.15 K, equalling exactly 0° on the Celsius temperature scale. The Celsius scale, which is identical to the centigrade scale, is named for the 18th century Swedish astronomer Anders Celsius, who first proposed the use of a scale in which the interval between the freezing and boiling points of water is divided into 100 degrees. By international agreement, the term Celsius has officially replaced centigrade.

The boiling and freezing points are those of water at mean sea level, atmospheric pressure.

Freezing point, or 32° Fahrenheit = Zero in Centigrade (also Celsius) or Reaumur.

Boiling, or 212° Fahrenheit (F) = 100° Centigrade ©, or 80° Reaumur ®

The number of degrees between freezing point and boiling point of water is 212 - 32 = 180°, on Fahrenheit scale, 100° on the Centigrade scale, and 80° on the Reaumur scale. The magnitude of the degrees FAHRENHEIT* relative to degrees CENTIGRADE is thus as 5 to 9

Kelvin (k): – A unit of temperature equal to the Celsius degree in the Kelvin scale 0° fixed as absolute zero (- 273.15° C or -459.69° F)).

*Fahrenheit: Gabriel Fahrenheit, a German physicist (1686 – 1736). His name is given to the commonly used thermometer scale in which the freezing point is 32 degree, and the boiling point 212 degree.

Thermometer

Thermometer is an instrument containing a substance, the volume of which is altered by temperature. Thus, the thermometer is designed to measure temperature of a substance or body.

Mercury is generally used as a thermometer fluid rather than water because it has greater visibility than that of water.

In cold countries, alcohol is preferred to mercury as a thermometer fluid because alcohol has a very low freezing point.

Reaumur thermometer

A thermometer used in a number of European countries. Zero, 0 degree is given as the melting point of the ice and 80 degrees as the boiling point of water.

Clinical Thermometer

The clinical thermometer is a special liquid-in-glass thermometer. This thermometer is specially designed to measure human body temperature. Normal body temperature is 300 C (98.40F).

Pyrometer

Pyrometers are instruments used for measuring high temperatures using emitted radiation of about 900 K. it uses the radiation emitted by a hot body as a basis for measurement.

Recording thermometer

A thermometer that makes a permanent record of variations in temperature, usually by an inked line traced automatically on a paper disk or roll.

Thermometer test

To test a mercurial thermometer, invert it. The mercury should strike the end with a click, showing the vacuum is perfect. Detach a piece of mercury by a jerk, this piece should read the same length at all parts of the tube (this verifies the parallelism of the tube). The thermometer in melting ice should read 32° Fahrenheit, in steam 212° Fahrenheit.

All thermometers have small errors. Where great accuracy is required, they should be compared with standard thermometer, for every 10°, errors noted and added to or subtracted from the observations.

High temperature

Determination of temp

by cooling heated iron in water

H = temperature of the heated iron.

T₀ = temperature of the water before cooling the iron in Fahrenheit

T = temperature of the water after cooling the iron in Fahrenheit.

S = specific heat of the iron (0.13 for cast iron. 0.113 for wrought iron)

W_{iron} = weight of the iron

W_{water} = weight of the water in which iron is cooled

$$H = T + \frac{W_{\text{Water}}(T - T_0)}{S \times W_{\text{iron}}}$$

Judgement of temp by colour

Colour	° F	° C
Faint red	960	516
Dull red	1290	699
Brilliant red	1470	743
Cherry bright	1650	899
Cherry red	1830	999
Orange	2010	1099
Bright orange	2190	1199
White	2370	1299
Bright white	2550	1399
Brilliant white	2750	1510

Oxy-acetylene flame has the maximum temperature.

Decrease of temperature with altitude

The temperature decreases at different altitudes.

Temperature decreases 1 degree C per 160 metres at higher altitude of the environment.

Every degree centigrade corresponds with from 150 to 260 metres, or an average of about 200 metres.

Or, every degree Fahrenheit from 273 feet in summer to 474 feet in winter; or an average of 364 feet per degree Fahrenheit.

Increase of temperature below surface of the earth

One degree centigrade for every 31 to 32 metres depth; or, one degree Fahrenheit for every 57 feet depth, when volcanic disturbance does not affect the temperature,

The mean temperature of any place at sea level should vary approximately as the cosine of the latitude (if there are no disturbing causes). The mean temperature at the equator may be taken as 80 degrees Fahrenheit.

Sound

Sound is particular auditory effect produced by a given cause

Frequency of sound

Sound travels in the form of waves and it is longitudinal waves and is caused by vibrations. Sound can only travel through a medium. It cannot travel through vacuum. It travels through solids, liquids, and gases.

Sound is propagated in the form of longitudinal waves. When sound travels from one medium to another, both its velocity and wavelength undergo changes. The velocity of sound in a given medium is obtained by the equation $v = n W$, where 'n' is the frequency of sound and 'W' is its wavelength in that medium. Velocity of sound is directly proportional to the wavelength. Thus, if the velocity of sound doubles when it travels from one medium to

another, its wavelength also doubles. The frequency of sound depends upon the source of sound, not the medium of propagation. Hence, it does not change.

Sound may be characterised essentially by three properties:

Loudness (The magnitude of sound (usually in a specified direction))

Pitch (The property of sound that varies with variation in the frequency of vibration)

Quality

Loudness of a sound depends on the amplitude of vibration of the sound-making object and on the distance from the object to the ear.

Pitch is the highness or lowness of a sound.

The intensity of sound is measured in decibel.

When the reflected sound is heard separately, it is called echo. An echo is always much weaker than the original sound.

Resonance is a phenomenon of forced vibrations due to which sound waves can be produced with a large amplitude or intensity.

Ultra sonic

The word ultra sonic relates to mechanical vibration of very high frequency above 30,000 cycles per second.

Infrasonic

Infrasonic sound – below the audible sound

Audible

Audible sound – 20 Hz to 20,000 Hz

Speed of sound

At sea level = 340.29 m / s

If we consider the atmosphere on a standard day at sea level static conditions, the speed of sound is about 761 mph, or 1100 feet/second.

Speed of sound in air is 345 metre per second

Sound barrier

The velocity of sound in dry air is approximately ' $331.41 + 0.6 T$ ' metre per second, where T = Celsius temperature. This limit is called the sound barrier for an aircraft or any flying object. As an aircraft approaches the speed of sound, shock waves build up, creating increase in drag, loss of lift and loss of control. This makes the aircraft shaky when it crosses the speed of sound in the air. As an airplane flies faster than the speed of sound, it 'pushes' on the sound waves in front. However, sound waves cannot travel faster than the speed of sound. So, they pile up against each other as they are created and are called shock waves.

Sound scale

Decibel

A unit used to express differences in power, esp. in acoustics or electronics: equal to ten times the common logarithm of the ratio of two signals. Abbr.: dB

Decibel (dB) is a unit for measuring the relative loudness of sounds, or for measuring power levels in electrical communications.

It is essentially the logarithm of a ratio of pressure or energies usually expressed by the formula:

$$dB = 20 \log \frac{P_1}{P_2}$$

A reference must be given. In hearing, the reference level is a pressure of 0.0002 dyne per square centimetre.

Intensity of sound

20 dB	Ticking of clock
30 dB	Typical bedroom sound
29 to 43 dB	Noise from a best quality air conditioner
40 – 30 dB	Polite conversation
45 dB	Sounds that cause restless sleep
55 dB	Cannot hear conversation
60 dB	A simple output deck

Wave

Wave motion is a form of energy. Each wave has its own wavelength, frequency, amplitude, and form.

Sound in air is the good example of longitudinal wave.

The time taken to complete one vibration is called the period and is denoted by 'T'. The number of vibrations per second is called frequency, denoted by 'n'. It is measured in Hertz (Hz), which is defined as the number of cycles per second.

The distance between any two consecutive crests of any two consecutive troughs is always the same, is called wavelength, and is denoted by Lambda (λ).

The speed (V) of all kinds of waves is given by the relation:

$$V = \text{frequency} \times \text{wavelength} = n \lambda$$

Energy/Power

Power

Power is the rate at which work is done. The SI unit of power is 'Watt'.

$$\text{Power} = \frac{\text{work done}}{\text{time taken}}$$

1 horse power = 7.46 watt

Energy

Energy is defined as the capacity to do work. It is of two kinds: kinetic and potential energy.

It is also measured in Joule (j).

Potential energy (pe)

Potential energy is the energy of a body or a system with respect to the position of the body or the arrangement of the particles of the system.

$$PE = m \times g \times h$$

Where m = mass, g = gravitation, h = height.

Kinetic energy

Kinetic energy is the energy a body possess by virtue of motion, and is expressed in Foot-pounds

V = velocity or speed in feet per second.

W = weight in pounds. W is the total dead weight plus an addition to represent the stored energy of rotating parts; it is convenient to add this stored energy in rotating parts as a percentage of the dead weight.

Kinetic Energy in Foot-pound

$$\frac{W \times V^2}{2 \times g} = \frac{W \times V^2}{2 \times 32.2} = 0.01553 \times W \times V^2$$

For W in tons and V in miles per hour, kinetic energy in foot-pound = **74.82 × W × V²**

Since 1 watt-hour = 2654 foot-pound:

Kinetic energy in watt-hours = **0.2819 × W × V²**

In general term kinetic energy = $\frac{1}{2} mv^2$, where m is the mass of the body and v is its speed.

Albert Einstein showed the energy (E) is associated with a mass (m) is given by the formula:

$$E = mc^2$$

Where 'c' is the speed of light in vacuum (= 3×10^8 kilometre per second)

Horsepower

Horsepower is the unit of power in the English system for measuring the rate at which an engine or other prime mover can perform mechanical work. It is usually abbreviated hp. Its electrical equivalent is 746 W, and the heat equivalent is 2545 BTU. One horsepower was originally defined as the amount of power required to lift 33,000 pound 1 feet in 1 minute, or 550 foot-pounds per second.

The British engineer and inventor James Watt established this value for the horsepower after determining in practical tests that horses could haul coal at the average rate of 22,000 foot-pounds per min. He then arbitrarily raised this figure by a factor of one-half to establish the current value. In the metric system, 1 horsepower is sometimes called force de cheval or

cheval-vapeur and is defined as 4500 kilogram-metre per minute, which is equivalent to 32,549 foot-pounds per min, or 0.986 of the English horsepower unit.

Three different horsepower values are used to quote the performance of an engine:

Indicated horsepower is the theoretical efficiency of a reciprocating engine, which is determined from the pressure developed by the cylinders of the engine;

brake or shaft horsepower is more commonly used to indicate the practical ability of the engine, or the maximum performance, which is the indicated horsepower minus the power lost through heat, friction, and compression;

Rated horsepower is the power that an engine or motor can produce efficiently for sustained periods.

Electric motors are capable of surges of power far in excess of their rated horsepower). British automobile engines are classified in rated horsepower, but their brake horsepower may be four to six times the rated horsepower. The power output of American automobile engines is quoted in brake horsepower, most being rated between 60 and 200 hp.

(In METRIC system, substitute 'feet' with "Metre" in the above formulae.)

Measurement of radius & circumference of earth

Greek philosopher Eratosthenes in 200 B. C. first measured the dimensions of the earth by using simple geometric methods. He dug a narrow well at Syene (now Aswan). The well would reflect the sunlight at about 90 degree on the first day of summer at Alexandria, about 5000 Stadia north of Syene (1-Stadia was about 100 yards or 0.16 kilometre); he placed a stick and measured the length of the shadow at noon of the first day of summer. By applying trigonometric calculations, he obtained a displacement angle of 7.2 degrees. The fraction of the Earth's circumference lies between Alexandria and Syene, and its proportion to this displacement angle. Now 7.2 degrees is 1/50 of the full circle, which means that the distance between those two cities is 1/50 of the Earth's circumference. To get the size of the earth, he multiplied 50000 Stadia with 50. To get the radius of the earth, he divided the circumference of the earth by two and pi. He got the radius of the earth to be 6366 kilometres. The radius of the Earth using satellites is 6378 kilometres.

Speedometer

Speedometer, also tachometer, is a device for measuring the speed of a vehicle. This is usually done either by measuring the number of revolutions over a known time interval, or by devising an instrument that measures revolutions per minute (RPM) directly. An example of such a device is the automobile speedometer, in which a flexible cable attached to the drive rotates a permanent magnet in the instrument. This induces a magnetic field on a surrounding drum, tending to drag the drum around with it. The drum is restrained by a spring, to which a pointer is connected. The higher the speed of the engine, the higher will be the drag induced, and with it the deflection of the pointer. Speedometers also sometimes employ a small electric generator, the output voltage of which varies with the rotational speed. Other types of speedometers are operated by centrifugal force, driving a set of revolving fly ball weights

outward as speed is increased. These weights are connected through a linkage to a spring, which is compressed as the speed increases, and to which a pointer is connected. This type of device first found wide application when the British engineer and inventor James Watt introduced it as a governor to control steam engines.

An airplane-engine speedometer, or speed indicator, depends on the measurement of dynamic pressure. A so-called Pitot tube, named after the French physicist and engineer Henri Pitot, extends in front of the craft, and brings the air stream flowing past the plane to rest. The speed of a craft in water is frequently measured by a towed instrument, consisting of a small propeller, the rotational speed of which increases with forward speed, actuating a calibrated dial aboard the craft.

The term tachometer is usually applied to an instrument used to measure angular speed, such as that of a shaft, in revolutions per minute.

Spring

Spring, in mechanics, is a device made of an elastic material that undergoes a significant change in shape, or deformation, under an applied load. Springs are used in spring balances for weighing and for the storage of mechanical energy, as in watch and clock springs or door-closing springs. Springs are also used to absorb impact, as in coil or leaf springs used for automobile suspensions, and to reduce vibration by the use of rubber blocks. The specific form of a spring depends on its use. A weighing spring, for example, is normally wound as a helix, and its elongation is proportional to the applied force, so that the spring can be calibrated to measure this force. Watch springs are wound as spiral coils, and sets of flat bars or leaves, superimposed on one another to form laminations, are used as leaf springs in automobile suspensions.

Bolometer

An instrument used to measure tiny amounts of radiant energy, ranging from light waves to microwaves. Invented in 1860 by American scientist Samuel Pierpont Langley, it is now used primarily to detect heat energy from distant sources. In astronomy, for example, bolometer measures the heat of stars. The instrument, in its basic form, is a Wheatstone bridge with two platinum strips. When one strip receives radiation, its slight change in resistance compared to the other strip is measured. This difference indicates the amount of radiation received. More advanced forms of bolometer have been developed.

Hardness (minerals)

The hardness of minerals is measured by an arbitrary scale 'Moh's scale of hardness', which is as under:

Substance	Hardness scale	Substance	Hardness scale
Diamond	10	Penknife	5.5
Silicon carbide (Carborundum)	9.5	Apatite	5
		Fluorspar	4
Corundum	9	Calcite	3
Topaz	8	Fingernail	2.5
Quartz	7	Gypsum	2
Orthoclase feldspar	6	Talcum	1

In this scale, the number indicates that the mineral will scratch all minerals with a lower number.

Hardness of metals is measured by more methods that are elaborate since hardness is related to the tensile strength of a metal.

Scales

Baumé scale	A scale for use with a hydrometer, calibrated so that the specific gravity of a liquid may be easily computed.
Brix scale	A graduated scale, used on a hydrometer that indicates the weight of sugar per volume of solution
Beaufort scale	A scale for indicating the force or speed of wind, using numbers from 0 to 12 or sometimes 17
Mohs scale	A scale of hardness for minerals, consisting of the following degrees, in increasing hardness: talc 1; gypsum 2; calcite 3; fluorite 4; apatite 5; orthoclase 6; quartz 7; topaz 8; corundum 9; diamond 10.
Richter scale	A logarithmic scale for expressing the magnitude of an earthquake